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DC Diaphragm Discharge in Water Solutions

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This contribution is focused on the investigation of the non-pulsed DC diaphragm discharge in water solutions. The optical emission spectroscopy was used for investigating the light spectrum of the diaphragm discharge in the solution. The light intensity was dependent on the initial discharge conditions.

1. Introduction

The electrical discharges in liquids have been a subject of research during a few last years [1, 2]. Especially point to plane and coaxial geometry were used. The high voltage used for creating the discharge was usually pulsed. Therefore, this work is focused on the diaphragm discharge with an applied non-pulsed DC high voltage which combination is not so common. The diaphragm discharge is also called „electrodeless" discharge because the electrodes does not disturb the discharge process.

2. Experimental setup

A batch discharge reactor was used in our experiments (Fig. 1) [3]. It consists of two parts with one stainless steel electrode in each part (negative, positive). The dielectric diaphragm with a small pinhole (PTFE, 0.25 mm) separated the both parts. The electrodes were installed in the distance of 2 cm from the diaphragm.

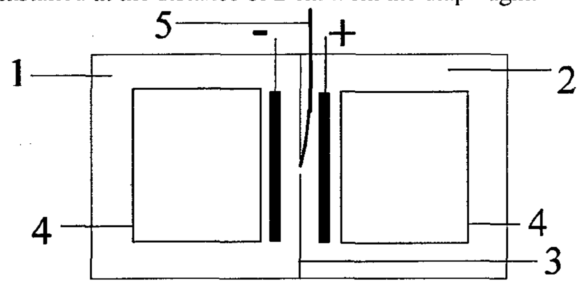

Fig. 1: The scheme of the batch reactor; 1 – negative part, 2 – positive part, 3 – diaphragm with pin hole, 4 – cooling boxes with ice-pack, 5 – optical fibre.

A non-pulsed DC high voltage from 1.4 to 2.8 kV was applied on the electrodes. To protect liquid before heating by the discharge, two cooling boxes with icy water were placed in the both parts of our reactor. NaCl and Na_2HPO_4 salts were used to obtain the defined conductivity of initial demineralized water.

The optical emission spectroscopy was used for investigating the light spectrum of the diaphragm discharge in the solution. Especially hydroxyl radicals and some elements contained in salt (Na) were determined by this method.

3. Results and discussion

During the experiments the emission spectra of the discharge were observed. The investigation was focused on the emission intensity of the hydroxyl radicals generated by the diaphragm discharge. The observations were done in both salts (NaCl and Na_2HPO_4) and the discharge conditions were varied; the applied high voltage was used in the range 1.4 – 2.8 kV, the initial conductivity was 400 or 550 $\mu S \cdot cm^{-1}$ (the maximum hydrogen peroxide generation is reached at these two conductivities [3]). It was found that the light intensity of hydroxyl radicals decreases in both salts during the discharge. In Fig. 2 is shown an example of the OH integral intensity (306.5 – 318 nm) as a function of time.

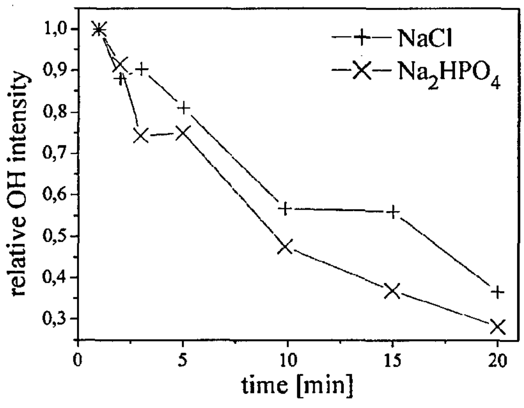

Fig. 2: The OH integral intensity as a function of time.

The evolution of this dependence might be caused by the decrease of OH radicals in the synthetic reaction which leads to the production of the hydrogen peroxide. This phenomenon was a subject of previous studies [3].

The influence of the applied high voltage on the emission intensity is demonstrated in Fig. 3. The increasing OH integral intensity with increasing voltage is evident from this picture and it corresponds with the increase of the hydrogen peroxide production as it was observed recently [3] and it is demonstrated in Fig. 4.

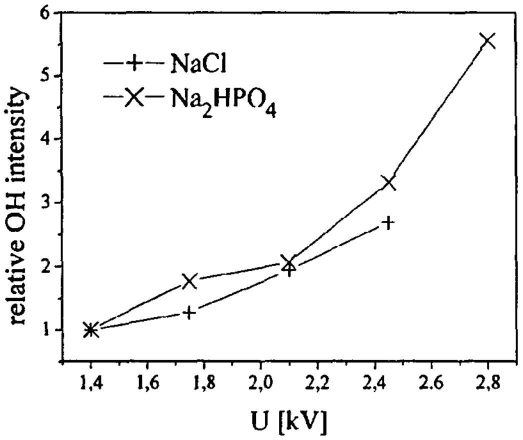

Fig. 3: The OH integral intensity as a function of the applied voltage.

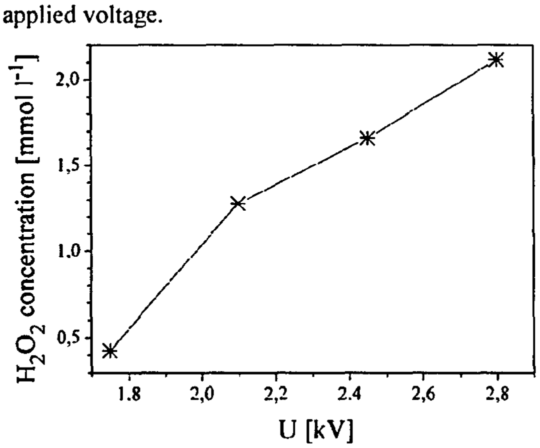

Fig. 4: Hydrogen peroxide generation as a function of applied voltage (3mM NaCl, initial conductivity 300 μS/cm)

The OH emission intensity also depends on the initial conductivity of the solution and used salt. The production of the hydroxyl radicals is higher in case of Na_2HPO_4 salt (see Fig. 3) and increases with the increase of the initial solution conductivity.

An interesting phenomenon was observed - the initial conductivity increased in time. The magnitude of the conductivity change was higher in the positive part of the reactor. In both parts the final conductivity had stabilized on the constant value after 60 minutes of the experiment. The increase was caused by metallic traces involved from electrodes by the electrolysis.

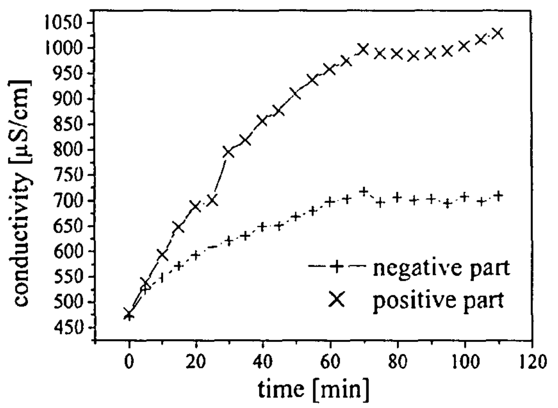

Fig. 5: Conductivity changes (5 mM NaCl, 2.8 kV)

4. Conclusion

The results of the optical emission spectroscopy applied on the non-pulsed DC diaphragm discharge are presented in this contribution. The OH integral intensity was counted and shown as a function of time and applied voltage. The light intensity decreases during the discharge and increases with increasing high voltage. The initial conductivity of the liquid also affects the light spectrum. The dependence of the emission intensity of hydroxyl radicals on the applied salt was studied.

5. Acknowledgement

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6. References

[1] A. A. Joshi, B. R. Locke, P. Arce, W. C. Finney, *Hazard. Mater.* **41** (1995) 3.

[2] P. Sunka, V. Babicky, M. Clupek, P. Lukes, M. Simek, J. Schmidt, M. Cernak, *Plasma Source Sci. Tech* **8** (1999) 258.

[3] F. Krcma, Z. Stara, *Chemical Papers* **96** (2002) 82.